

# ECON 222A

## Macroeconomic Theory I

The IS–LM/AD–AS Model

Lecture 15

# Today's Lecture

- Tutorial?

# Today's Lecture

- The FE Line (Labor Market)
- The IS Curve (Goods Market)
- The LM Curve (Asset Market)
- General Equilibrium in the IS-LM
- Attainment of General Equilibrium

# IS-LM Model Background

- 1936 Keynes' *General Theory* after the Great Depression, capitalism in doubt
- Tried to distance his theory from classical economics and the invisible hand
- Argues that capitalism needs government demand stabilization (with fiscal policy)
- 1937 Hicks put book into a model (diagrams our main tool)

# IS-LM Model Background

- Main criticism lodged against IS-LM: expectations should be more explicit
- Today GE modeling with computers and simulations is becoming the standard of serious academic and policy research
- IS-LM is what economists typically think of when doing macro policy

# IS-LM Model Background

- Interest Rates: *nominal* for LM curve, *real* for IS curve
- Laidler: IS-LM facilitated the rise of ideas that fit into the framework and neglect of those that didn't. Time was ignored, as were the importance of the policy regime (expectations) and transmission mechanism (credit channel), and coordination failures.
- Mainly Graphical analysis (algebra in appendix, and last assignment)
- Economy closed for now, open from next week.

# Introduction to the IS-LM(-FE) Model

- This name originates from its basic equilibrium conditions:
  1. investment,  $I$ , must equal saving,  $S$ ;
  2. money demanded,  $L$ , must equal money supplied,  $M$ .

# Introduction to the IS-LM Model

- We'll use IS-LM to illustrate Keynesian and Classical approaches.
- 'General' Equilibrium: Simultaneous clearing of three markets:
  - Labor (Full-employment)
  - Goods (IS curve)
  - Asset (LM curve)



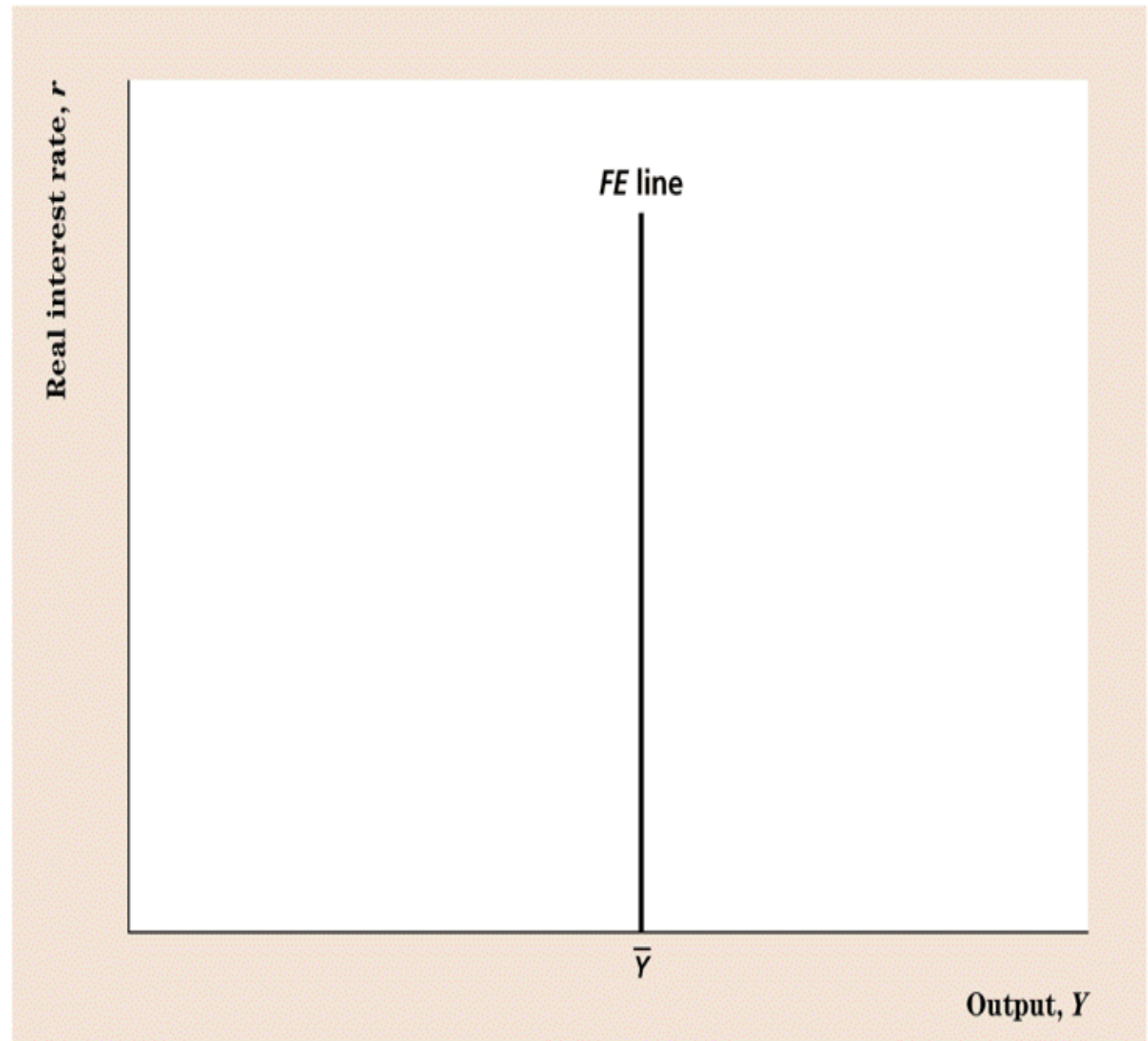
# Labor Market Equilibrium (FE)

- FE: full employment curve
- Equilibrium level of  $N$  that is reached after wages and prices have fully adjusted so  $N^S = N^D$  in the labor market
- Full employment output is  $\bar{Y}$  at this level
- It's a vertical line, in the  $(Y, r)$  diagram
- $r$  has no role for full employment: only affects firms' long run investment decisions

## FIGURE 9.1

### THE *FE* LINE

The full-employment (*FE*) line represents labour market equilibrium. When the labour market is in equilibrium, employment equals its full-employment level  $\bar{N}$  and output equals its full-employment level  $\bar{Y}$ , regardless of the value of the real interest rate. Thus, the *FE* line is vertical at  $Y = \bar{Y}$ .

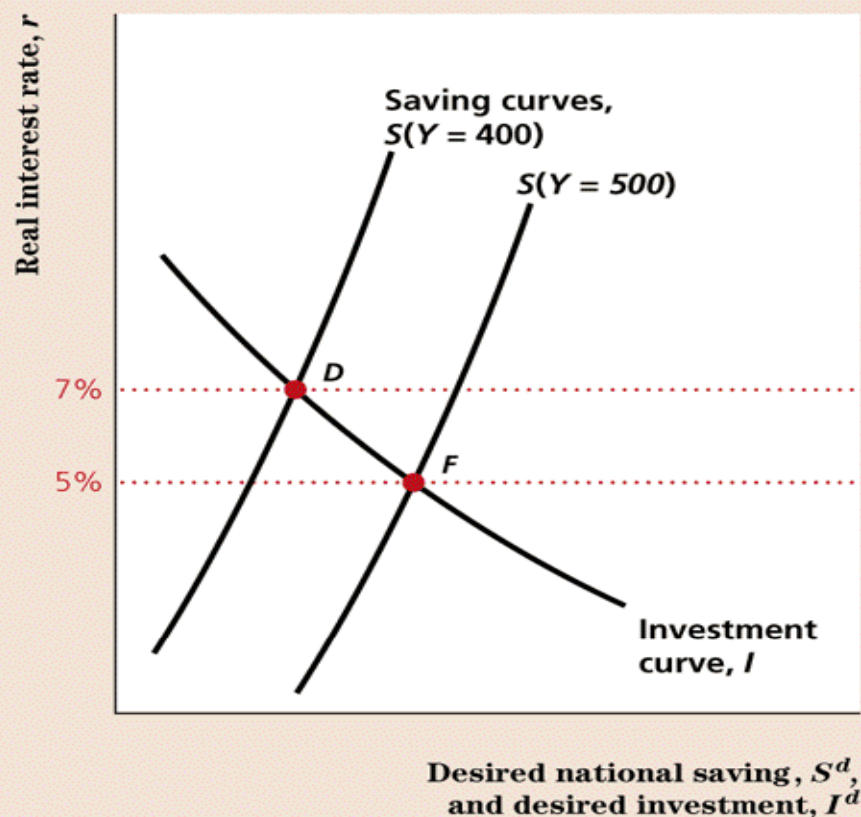


# Shifting FE

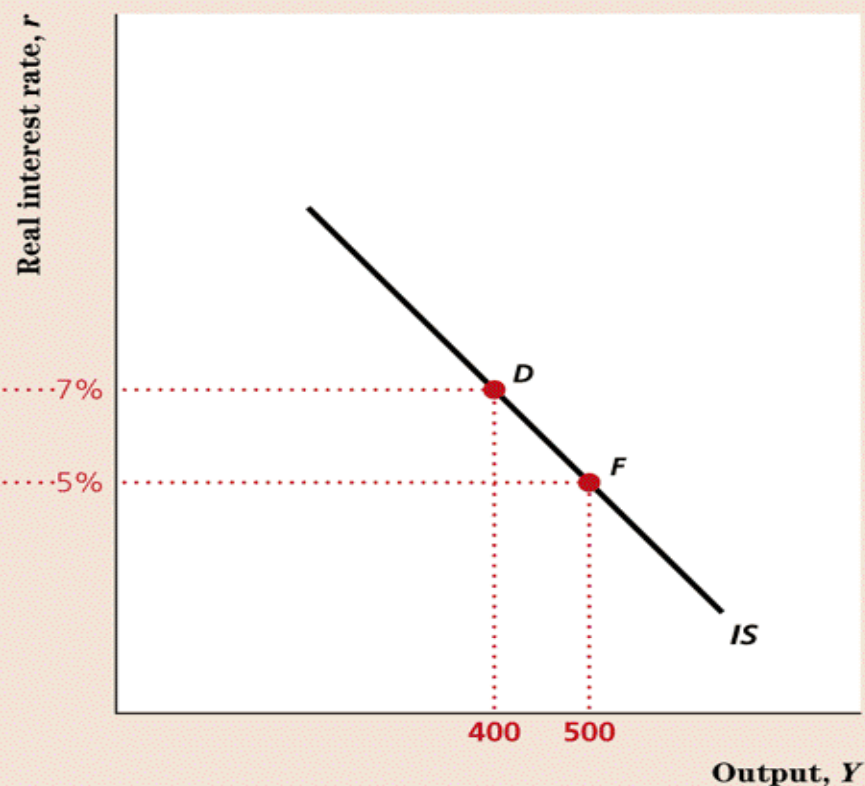
- From the analysis above, it should be clear that  $\bar{Y}$  shifts right if:
- Something shifts  $N^S$  or  $N^D$  curves right
- Beneficial supply shock (e.g. an increase in  $A$ )
- An increase in the capital stock

# IS Curve (Goods Market Equilibrium)

- In a closed economy,  $r$  adjusts so that  $I^d = S^d$
- Saving curve slopes up; Investment curve slopes down.
- IS curve: shows for any level of output,  $Y$ , the interest rate,  $r$ , which clears the goods market.
- At all points on the curve,  $I = S$  (thus the name).
- IS curve slopes down because an increase in  $Y$  leads to an increase in  $S^d$  and  $r$  must fall to clear the goods market.



(a)



(b)

## FIGURE 9.2

### DERIVING THE $IS$ CURVE

(a) The graph shows the goods market equilibrium for two different levels of output: 400 and 500 (the output corresponding to each saving curve is indicated in parentheses next to the curve). Higher levels of output (income) increase desired national saving and shift the saving curve to the right. When output is 400, the real interest rate that clears the goods market is 7% (point  $D$ ). When output is 500, the market-clearing interest rate is 5% (point  $F$ ).

(b) For each level of output the  $IS$  curve shows the corresponding real interest rate that clears the goods market. Thus, each point on the  $IS$  curve corresponds to an equilibrium point in the goods market. As in (a), when output is 400, the real interest rate that clears the goods market is 7% (point  $D$ ); when output is 500, the market-clearing interest rate is 5% (point  $F$ ). Because higher output raises saving and leads to a lower market-clearing interest rate, the  $IS$  curve slopes downward.

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# A Numerical Example

- Given the following information, derive the IS curve:
- $C^d = 360 - 200r + 0.10Y$ ,  $I^d = 120 - 400r$ ,  $G = 120$

- Savings = Investment

$$S^d = Y - C^d - G = Y - (360 - 200r + 0.10Y) - 120 = 0.9Y - 480 + 200r$$

$$I^d = 120 - 400r$$

$$0.9Y - 480 + 200r = S^d = I^d = 120 - 400r$$

$$0.9Y = 600 - 600r$$

$$600r = 600 - 0.9Y$$

$$r = a - bY$$

- For any  $Y$  we can obtain the  $r$  that clears the goods market.
- If  $Y=333.3$  (from  $L$  market) then:  $600r=600-0.9\cdot333.3$  and  $r=0.5$
- If  $Y=600$  (from  $L$  market) then:  $600r=600-0.9\cdot600$  and  $r=0.1$

# Factors That Shift the IS Curve

- IS curve consists of all the pairs  $(Y, r)$  such that the goods market is in equilibrium.
- For **constant output**, any change in the economy that reduces desired national saving relative to desired investment will increase the real interest rate that clears the goods market and, thus, shift the IS curve.

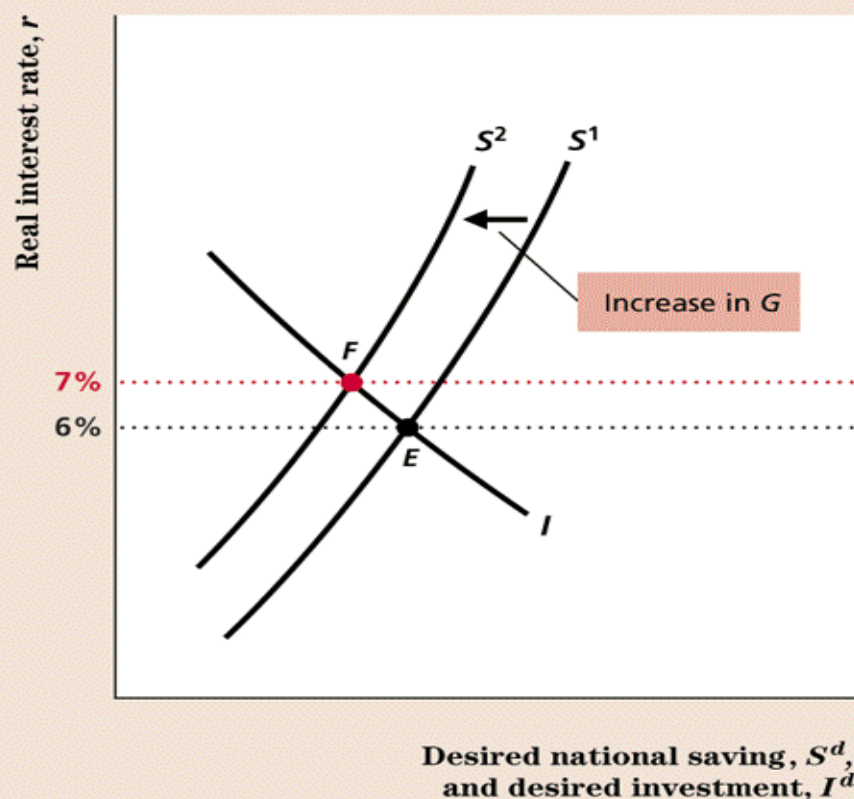
# Factors That Shift the IS Curve

- Factors that might cause  $S^d$  to **fall**:
- An increase in **Future Output** or **Wealth**, shifts IS up  
 $C^d$  increases,  $S^d$  decreases,  $r$  increases to clear goods market
- An increase in **G**, shifts IS up  
 $Y = I^d + C^d + G$   
 $I^d = S^d = Y - C^d - G$   
 $G$  increases,  $S^d$  decreases,  $r$  increases to clear goods market
- A decrease in **T**, shifts IS up, only if *RE* doesn't hold  
An increase in private (after-tax) disposable income,  $C^d$  increases,  $S^d$  decreases,  $r$  increases to clear goods market

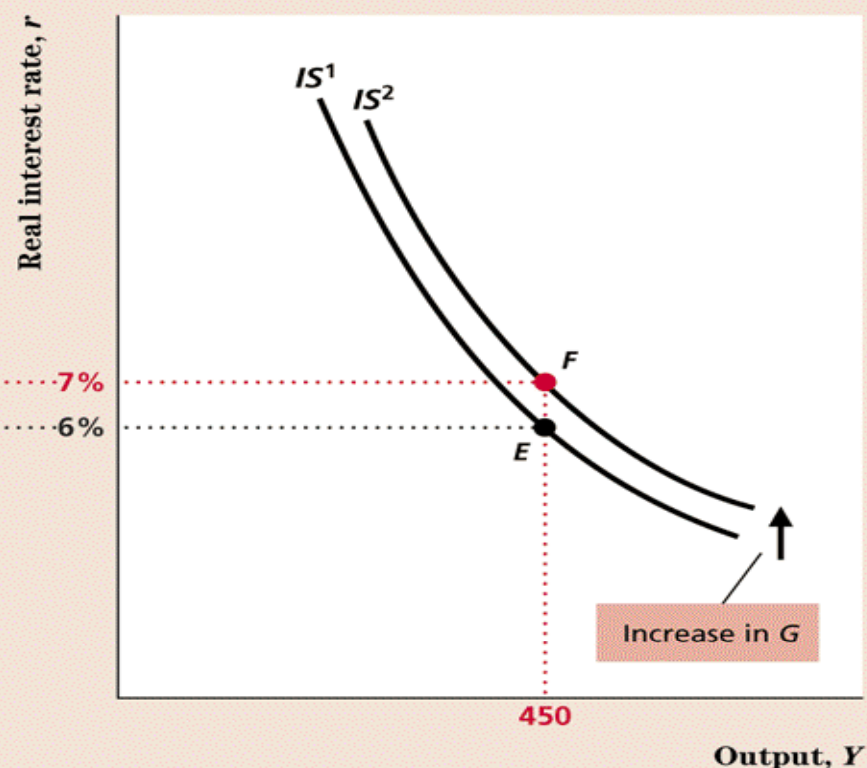


# Factors That Shift the IS Curve

- Factors that cause  $I^d$  to **rise**:
- An increase in the **expected future  $MPK$**
- A decrease in the **effective tax rate on Capital**
- All these effects are for **constant output**.



(a)



(b)

### FIGURE 9.3

#### EFFECT ON THE $IS$ CURVE OF A TEMPORARY INCREASE IN GOVERNMENT PURCHASES

(a) The saving–investment diagram shows the effects of a temporary increase in government purchases,  $G$ , with output  $Y$  constant at 450. The increase in  $G$  reduces desired national saving and shifts the saving curve to the left, from  $S^1$  to  $S^2$ . The goods market equilibrium point moves from point  $E$  to point  $F$ , and the real interest rate rises from 6% to 7%.

(b) The increase in  $G$  raises the real interest rate that clears the goods market for any level of output. Thus, the  $IS$  curve shifts upward from  $IS^1$  to  $IS^2$ . In this example, with output held constant at 450, an increase in government purchases raises the real interest rate that clears the goods market from 6% (point  $E$ ) to 7% (point  $F$ ).

# The Price of a Nonmonetary Asset and the Interest Rate

- Given the promised schedule of repayments of a bond or other nonmonetary assets, the higher the price of the asset, the lower is the **nominal interest rate** of the asset.
- For a **given rate of inflation** the price of a nonmonetary asset and its **real interest rate** are also inversely related.

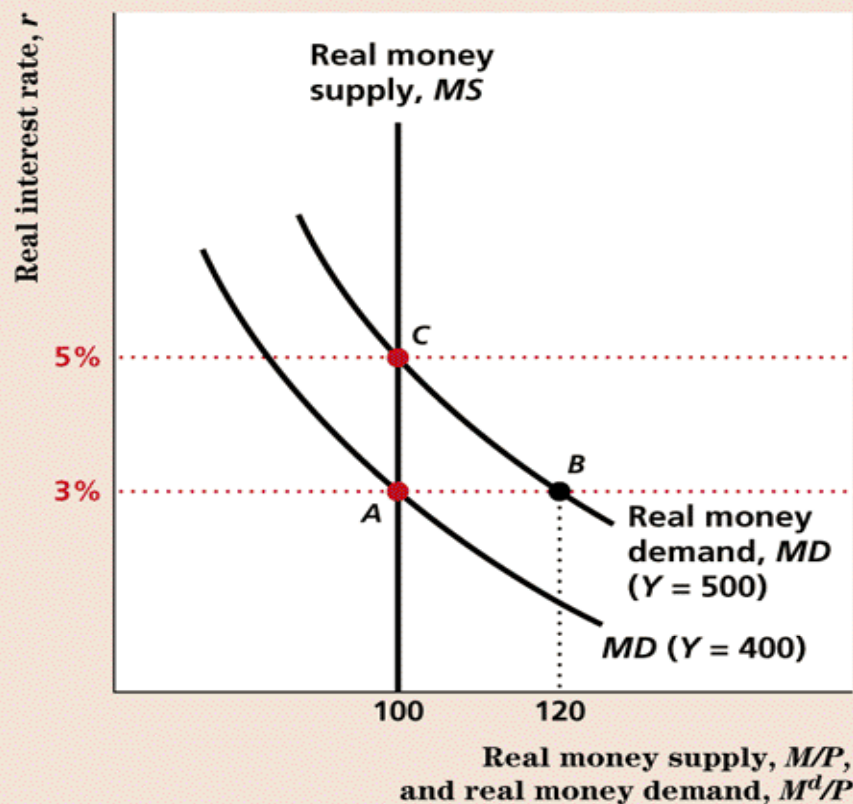
# The Equality of Money Demanded and Supplied

- The real money supply curve ( $M^S$ ) is a vertical line, it does not depend on the real interest rate.
- The money demand curve ( $M^D$ ) slopes downward. With higher  $r$  attractiveness of money as an asset decreases.
- Asset market equilibrium occurs at the intersection of the  $M^S$  and the  $M^D$  curves.
- When the  $M^D$  increases people sell nonmonetary assets, their price falls and the interest rate increases.

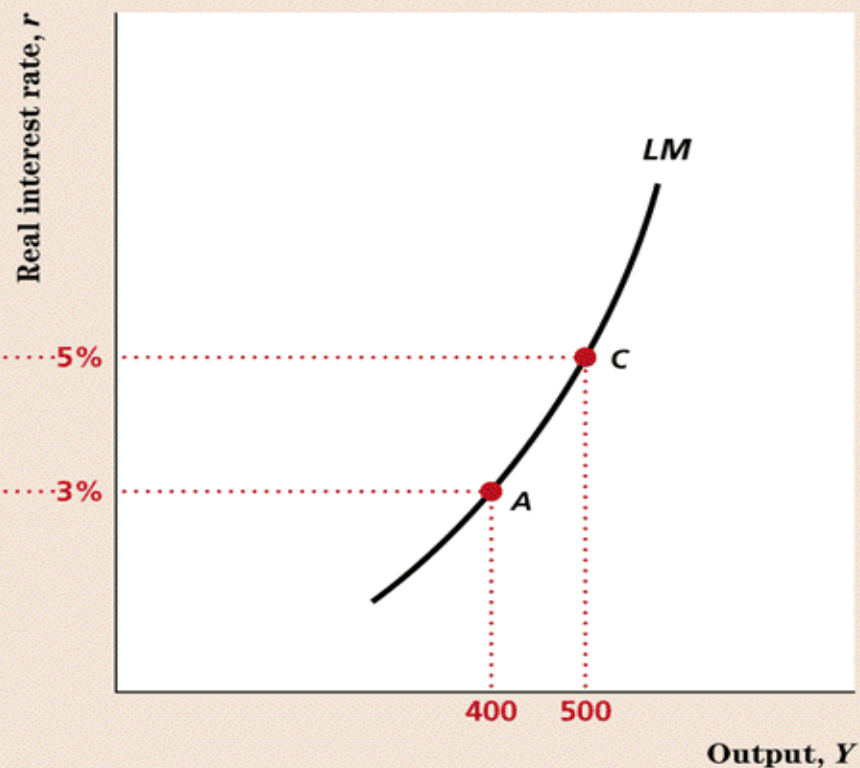
# The LM Curve:

## Asset Market Equilibrium

- The *LM* curve is a graphical representation of the relationship between output and the real interest rate that clears the asset market.
- The *LM* curve always slopes upward.
- At all points of the curve  $M^D = M^S$ .



(a)



(b)

## FIGURE 9.4

### DERIVING THE *LM* CURVE

(a) The curves show real money demand and real money supply. Real money supply is fixed at 100. When output is 400, the real money demand curve is  $MD (Y = 400)$ ; the real interest rate that clears the asset market is 3% (point A). When output is 500, more money is demanded at the same real interest rate, so the real money demand curve shifts to the right to  $MD (Y = 500)$ . In this case, the real interest rate that clears the asset market is 5% (point C).

(b) The graph shows the corresponding *LM* curve. For each level of output, the *LM* curve shows the real interest rate that clears the asset market. Thus, when output is 400, the *LM* curve shows that the real interest rate that clears the goods market is 3% (point A). When output is 500, the *LM* curve shows a market-clearing real interest rate of 5% (point C). Because higher output raises money demand, and thus raises the real interest rate that clears the asset market, the *LM* curve slopes upward.

# The LM Curve:

## Asset Market Equilibrium

- The  $LM$  curve slopes upward because an increase in  $Y$  leads to an increase in  $M^D$  and  $r$  must rise to clear the asset market (or else there would be excess  $M^D$ )
- If  $Y$  increases, the demand for real money ( $M/P$ ) increases, at any given  $r$ , and shifts  $M^D$  curve up.
- People try to sell assets for money.
- $M^S$  is fixed by Bank of Canada
- Price of asset falls/ $r$  increases
- Money demand decreases until  $M^D = M^S$

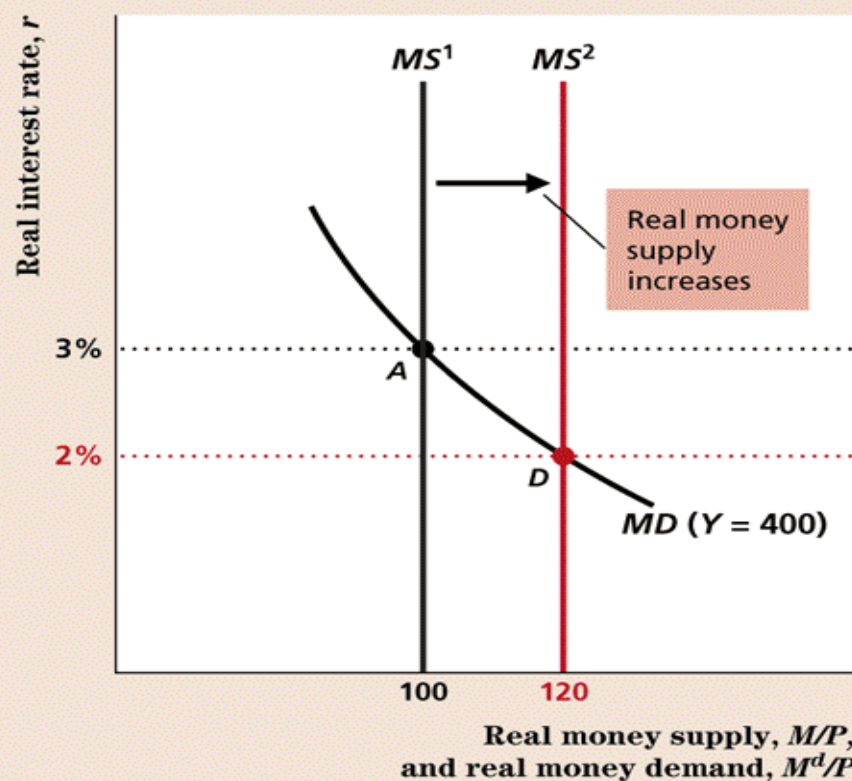
# Factors That Shift the LM Curve

- For constant output, any change that reduces real money supply relative to real money demand will increase the real interest rate that clears the asset market and cause the  $LM$  curve to shift up.
- Factors that might cause real money supply ( $M^S/P$ ) to rise:
  - An increase in the nominal  $M^S$
  - A decrease in the price level  $P$

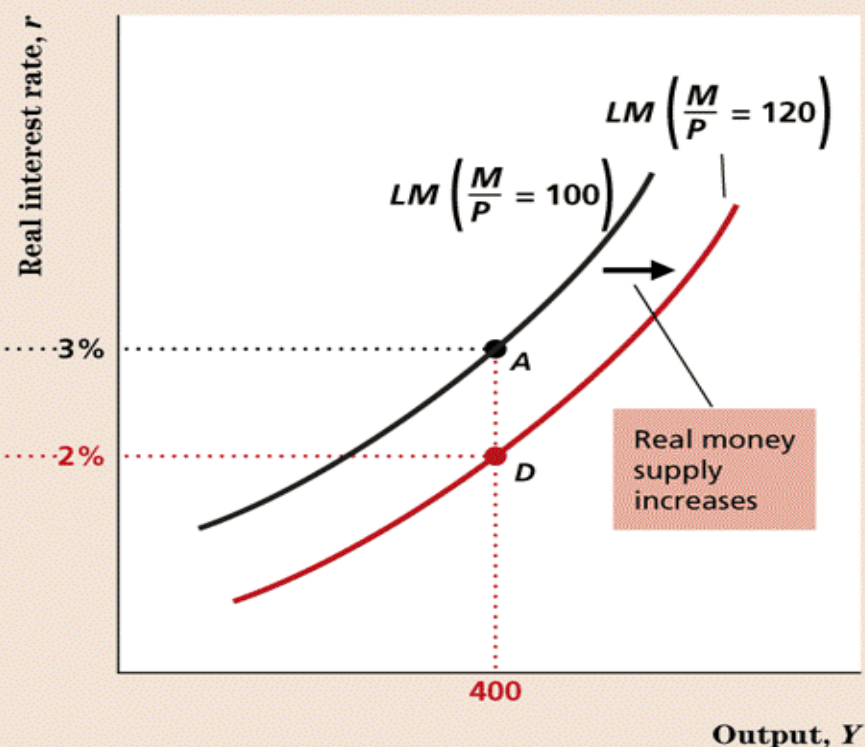


# Factors That Shift the LM Curve

- Factors that might cause  $M^D$  to fall:
- An increase in  $\pi^e$ , the expected inflation
- A decrease in  $i^m$  (interest bank pays on money)
- A decrease in Wealth (reduces number of transactions)
- A decrease in the risk of NM assets
- An increase in the liquidity of NM assets



(a)



(b)

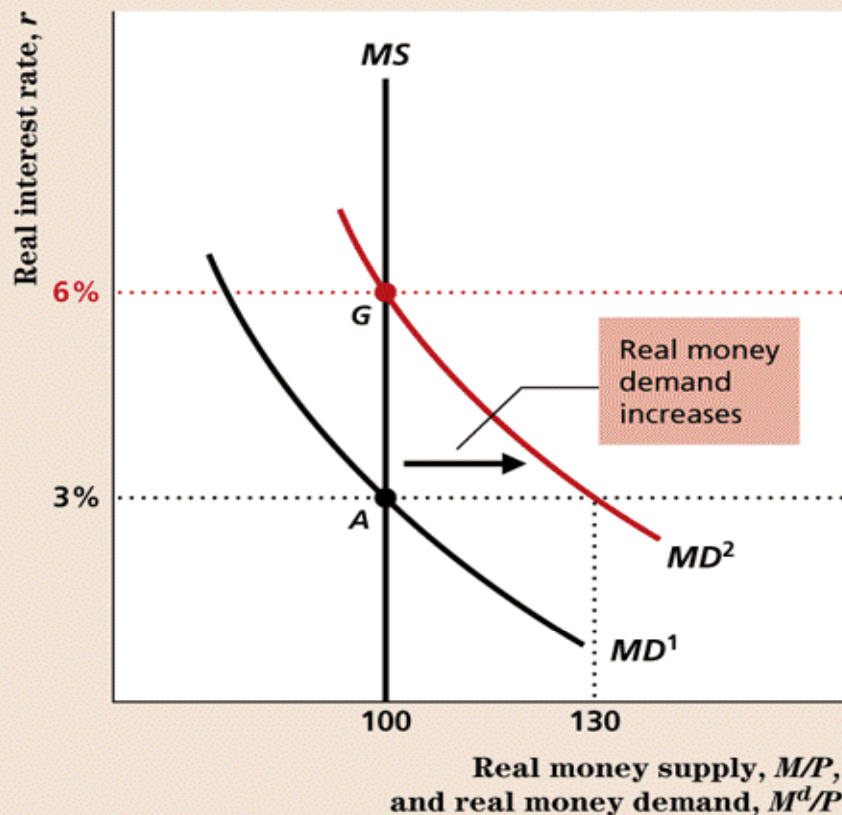
## FIGURE 9.5

AN INCREASE IN THE REAL MONEY SUPPLY SHIFTS THE  $LM$  CURVE DOWN

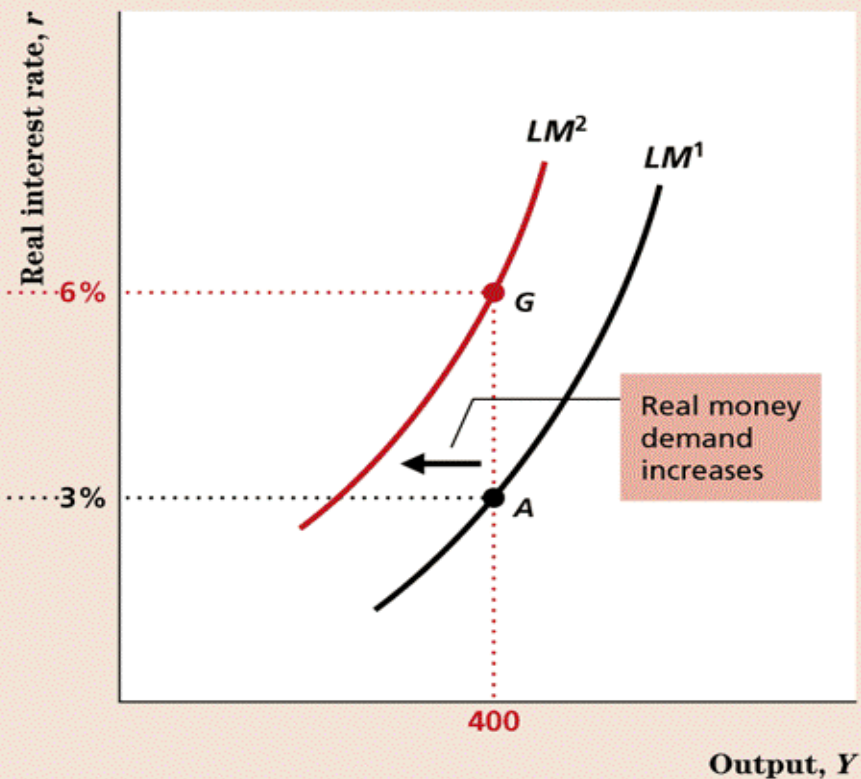
(a) An increase in the real supply of money shifts the money supply curve to the right, from  $MS^1$  to  $MS^2$ . For a constant level of output, the real interest rate that clears the asset market falls. If output is fixed at 400, for example, the money demand curve is  $MD (Y = 400)$  and the real interest rate that clears the asset market falls from 3% (point A) to 2% (point D).

(b) The graph shows the effect of the increase in real money supply on the  $LM$  curve. For any level of output, the increase in the real money supply causes the real interest rate that clears the asset market to fall. So, for example, when output is 400, the increase in the real money supply causes the real interest rate that clears the asset market to fall from 3% (point A) to 2% (point D). Thus, the  $LM$  curve shifts down, from  $LM$  for  $M/P = 100$  to  $LM$  for  $M/P = 120$ .

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(a)



(b)

**FIGURE 9.6**

**AN INCREASE IN REAL MONEY DEMAND SHIFTS THE  $LM$  CURVE UP**

(a) With output constant at 400 and the real money supply at 100, an increase in the interest rate paid on money raises real money demand. The money demand curve shifts to the right, from  $MD^1$  to  $MD^2$ , and the real interest rate that clears the asset market rises from 3% (point  $A$ ) to 6% (point  $G$ ).

(b) The graph shows the effect of the increase in real money demand on the  $LM$  curve. When output is 400, the increase in real money demand raises the real interest rate that clears the asset market from 3% (point  $A$ ) to 6% (point  $G$ ). More generally, for any level of output, the increase in real money demand raises the real interest rate that clears the asset market. Thus, the  $LM$  curve shifts up, from  $LM^1$  to  $LM^2$ .

# A Numerical Example

- Given the following information, derive the LM curve:
- $L=M^D/P=200+0.2Y-2000i$ ,  $M^S=300$ ,  $P=2$  and  $\pi^e=0.05$
- Impose the asset market clearing:  $M^D=M^S=M$

$$\begin{aligned}300/2 &= 200 + 0.2Y - 2000i \\150 &= 200 + 0.2Y - 2000(r + \pi^e) \\150 &= 200 + 0.2Y - 2000(r + 0.05) \\2000r &= -50 + 0.2Y \\r &= -50/2000 + 0.2Y/2000 \\r &= c + dY\end{aligned}$$

- For any  $Y$  we can obtain the  $r$  that clears the asset market.
- If  $Y=333.3$  then  $r=0.008$
- If  $Y=600$  then  $r=0.035$

# General Equilibrium in the Complete *IS-LM* Model

- The general equilibrium of the economy:
  - the *FE* line along with the labor market is in equilibrium;
  - the *IS* curve, along with the goods market is in equilibrium;
  - the *LM* curve, along with the asset market is in equilibrium.
- Labor market, Goods market and Asset market are simultaneously in equilibrium

# General Equilibrium in the Complete *IS-LM* Model

- The intersection of *FE*, *IS* and *LM* gives the equilibrium values of  $r$  and  $Y$
- We are also able to find  $w, N, C, I, M, P$
- In the short-run, the intersection of *IS* and *LM* is relevant
- In the long-run equilibrium, the intersection of *IS* and *FE* is relevant
- When not in GE, price adjustment shifts *LM* around to re-establish new GE.

## FIGURE 9.7

### GENERAL EQUILIBRIUM IN THE *IS-LM* MODEL

The economy is in general equilibrium when quantities supplied equal quantities demanded in every market. The general equilibrium point,  $E$ , lies on the  $IS$  curve, the  $LM$  curve, and the  $FE$  line. Thus, at  $E$ , and only at  $E$ , the goods market, the asset market, and the labour market are simultaneously in equilibrium.

